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Abstract

Contained are outlines for 18 one-hour lectures on oceanology. Each outline lists topics to be covered, suggestions on which topics should be covered most thoroughly, and books for further reading and related films. Lecture topics include: oceanographic surveying and research; geology of the oceans; physical properties of sea water; waves, tides and currents; chemistry of sea water; marine biology; food from the sea; air-sea interaction; sea ice; estuaries; man and the sea; the continental shelf; limnology; underwater sound; and conservation. Appendices list various resources: sources of instructional materials, charts, films and bibliographies, organizations and publications which can provide further information, and a selection of relevant scientific American offprints. (EB)

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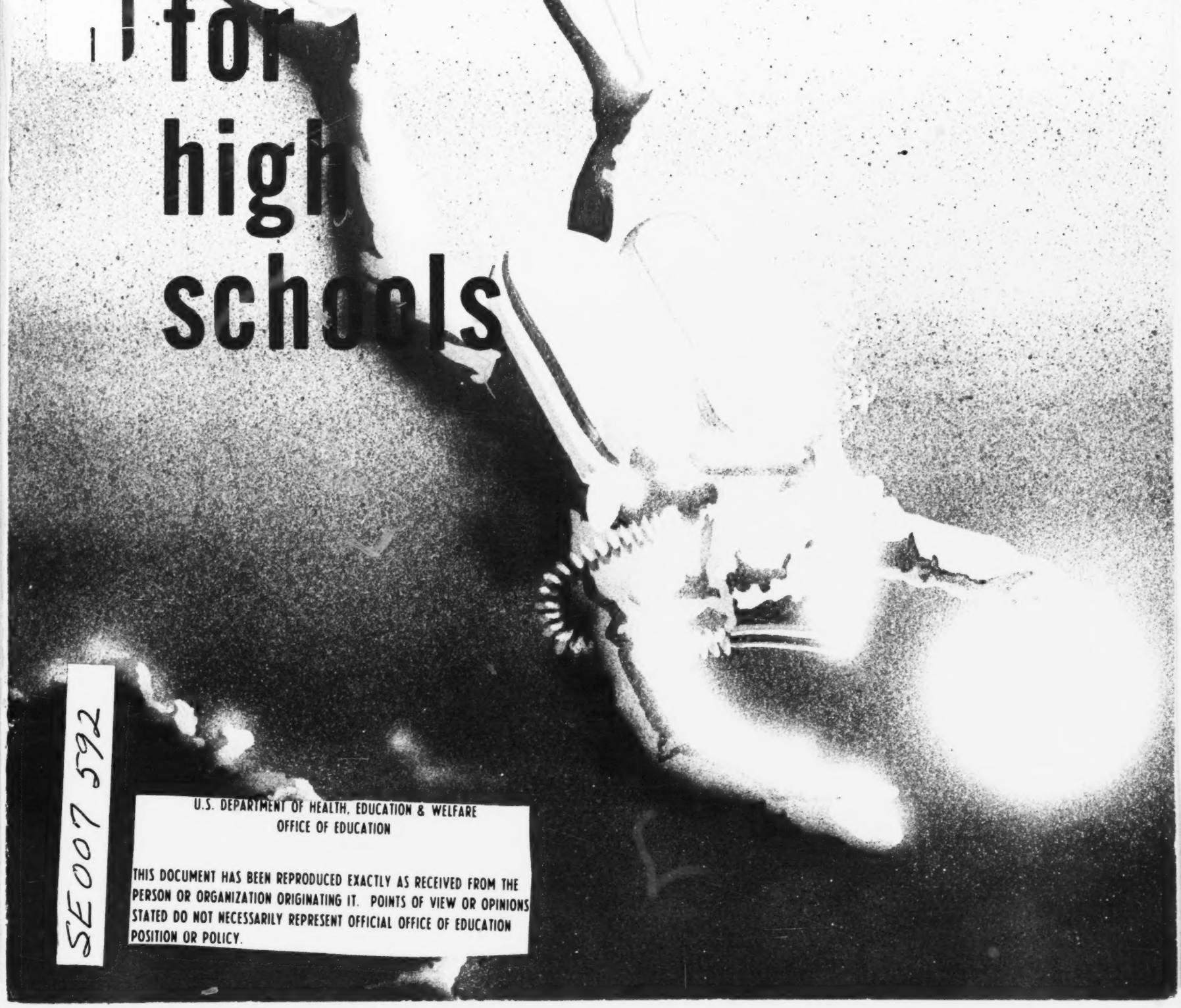
an oceanographic curriculum for high schools



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AN OCEANOGRAPHIC CURRICULUM FOR HIGH SCHOOLS

OUTLINE

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National Oceanographic Data Center

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INTRODUCTION

The National Oceanographic Data Center (NODC) has prepared this outline in response to queries from high school instructors interested in oceanography and also as a basis for lectures by members of the NODC staff. Since this outline will be revised on the basis of the experience and ideas of its users, comments are solicited.

At the discretion of the instructor, the 18 suggested one-hour lectures may be rearranged, augmented, or replaced by individual projects, demonstrations, laboratory work, or field trips. The additional readings and films listed may be applicable to more than one area and should be used where the instructor feels they are most appropriate.

Two publications, Questions about the Oceans and Topical Readings in Oceanography, are presently being prepared and will be available from the NODC in August 1968.

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1. INTRODUCTION TO OCEANOGRAPHY

Concepts Covered

Definition of oceanography and the interrelationship of disciplines

Major features of the oceans

Development of oceanography and its related concepts

Unsolved problems

Career opportunities and preparations for a career in oceanography

Preview of course content

Most Thorough Coverage

Development of oceanography and its related concepts

Further Reading

Interagency Committee on Oceanography.
University Curricula in the Marine Sciences. (ICO Pamphlet No. 30), Washington, D.C., 1967.

Naval Oceanographic Office.
Science and the Sea. Washington, D.C., 1967.

Williams, Jerome.
Oceanography: An Introduction to the Marine Sciences. Boston: Little, Brown and Company, 1962.

Film

Science of the Sea. 16mm, color, sound, 19 minutes, available from International Film Bureau, Inc., 332 South Michigan Avenue, Chicago, Illinois, 60604. Price: $195.00.

2. OCEANOGRAPHIC SURVEYING AND RESEARCH AT SEA

Concepts Covered

Research projects

Parameters to be measured

Oceanographic vessels

Platforms other than ships

Survey procedures and positioning

Instrumentation

Most Thorough Coverage

Research projects

Survey procedures and positioning

Instrumentation

Further Reading

Naval Oceanographic Office.
Instruction Manual for Oceanographic Observations.
Washington, D.C., 1959.

Film

Challenge of the Oceans. 16 mm, black and white or color, sound, 29 minutes, obtainable from McGraw-Hill Text Films, 330 West 42nd Street, New York, N. Y. 10036. Price: black and white, $90.00; color, $165.00.

3. GEOLOGY OF THE OCEANS

Concepts Covered

Nature of the sea floor--old concepts and recent discoveries

Methods of measuring and representing relief

The mantle and crust under the ocean

Sediments in the ocean

Formation of limestones by shell-building organisms

Geophysical measurements of gravity, magnetism, seismicity, and heat flow

Movement of the sea floor

Weathering of the earth's crust as a source of sea water constituents

Most Thorough Coverage

Nature of the sea floor--old concepts and recent discoveries

Further Reading

Engle, Leonard, and Editors of Life.
The Sea. Life Nature Library, New York, Time, Inc., 1961.

Shepard, Francis.
The Earth Beneath the Sea. Baltimore: Johns Hopkins Press, 1959.

Film

The Earth Beneath the Sea. 16 mm, color, sound, 27 minutes. Address inquiries to Lamont Geological Observatory of Columbia University, Palisades, New York 10964.

4. PHYSICAL PROPERTIES OF SEA WATER

Concepts Covered

Properties of pure water

Measured properties: temperature, salinity, and pressure; methods of measurement, units, and range in the sea

Computed properties: specific volume, density, compressibility, specific heat, sound velocity, etc.

Transmission of sound and light

Most Thorough Coverage

Measured properties: temperature, salinity, and pressure; methods of measurement, units, and range in the sea

Further Reading

Von Arx, William Stelling.
An Introduction to Physical Oceanography. Reading Massachusetts: Addison-Wesley, 1962.

Pickard, G.L.
Descriptive Physical Oceanography. Macmillan Company (Pergamon Press), 1964.

Film

The Restless Sea. 16 mm, color, sound, 1 hour, available free from local Bell System representative or affiliated company.

5. WAVES, TIDES, AND CURRENTS

WAVES

Concepts Covered

Definition

Surface waves: origin and characteristics

Breakers and surf

Destructive waves

Internal waves

Wave prediction

Wave measurement

Seiches in lakes and harbors

Most Thorough Coverage

Surface waves: origin and characteristics

Further Reading

Bascom, W.
Waves and Beaches, New York: Doubleday Anchor Original, 1964.

Clemens, Elizabeth.
Waves, Tides, and Currents. New York: Knopf, 1967.

TIDES

Concepts Covered

Tide-producing forces

Astronomical tides

Meteorological tides

Tidal bore

Tide prediction

Tide measurement

Most Thorough Coverage

Tide-producing forces

Further Reading

Darwin, G. H.
The Tides. San Francisco: Freeman and Company (paperback).

Defant, A.
Ebb and Flow. University of Michigan Press, 1958.

CURRENTS

Concepts Covered

Large scale currents

Currents related to the distribution of density

Effects of Coriolis Force

Effects of winds on currents

Tidal currents

Countercurrents

Measurement of currents

Most Thorough Coverage

Currents related to the distribution of density

Further Reading

Munk, Walter.
"Ocean Currents," Scientific American, September, 1955.

Stommel, Henry.
The Gulf Stream. Berkeley: University of California Press, 1958.

Films

Physical Oceanography. Film strip, 35 mm, color, narrated on record, 15 minutes. Address inquiries to Mr. Richard C. Vetter, Committee on Oceanography, National Academy of Sciences, National Research Council, 2101 Constitution Avenue, N. W., Washington, D.C. 20418.

Tides and Currents. 16 mm, color, sound, 15 minutes, available on free loan from ESSA, Washington Science Center, Rockville, Maryland 20852. When requesting, refer to P-1056-24.

6. CHEMISTRY OF SEA WATER

Concepts Covered

Composition of sea water--Dittmar's principle: constancy of composition

Salinity and chlorinity

Dissolved solids

Dissolved gases

Nutrients

CO_2/carbonate system

Oxidation and reduction in the sea water environment

Preparation of artificial sea water

Effects of formation and melting of ice

Most Thorough Coverage

Composition of sea water--Dittmar's principle: constancy of composition

Further Reading

"Chemistry and the Oceans," Chemical and Engineering News, Vol. 42, No. 22, June 1, 1964.

Sverdrup, H. U., Martin W. Johnson, and Richard H. Fleming.
The Oceans, Their Physics, Chemistry, and General Biology. New York: Prentice-Hall, Inc., 1946.

Film

Chemical Oceanography. Film strip, 35 mm, color, narrated on record, 15 minutes. Address inquiries to Mr. Richard C. Vetter, Committee on Oceanography, National Academy of Sciences, National Research Council, 2101 Constitution Avenue, N. W., Washington, D. C. 20418.

7. MARINE BIOLOGY--PART I

Concepts Covered

The food chain

Seaweed

Plankton and productivity

Nekton

Benthos

Most Thorough Coverage

The food chain

Further Reading

Clemens, Elizabeth.
Tide Pools and Beaches. New York: Knopf.

Hardy, Alister Clavering.
The Open Sea, Part I and II. Boston: Houghton Mifflin, 1957, 1959.

Films

Biological Oceanography. Film strip, 35 mm, color, narrated on a record, 15 minutes. Address inquiries to Mr. Richard C. Vetter, Committee on Oceanography, National Academy of Sciences, National Research Council, 2101 Constitution Avenue, N. W., Washington, D. C. 20418.

Survival in the Sea; the Life Cycle. 16 mm, black and white or color, sound, 29 minutes. Obtainable from Audio-Visual Center, Indiana University, Bloomington, Indiana 47405. Price: black and white, $125.00; color, $250.00.

8. MARINE BIOLOGY--PART II

Concepts Covered

Microbiology

Bioluminescence

Bioacoustics

Deep scattering layer

Dangerous and toxic organisms

Biodeterioration

Most Thorough Coverage

Biodeterioration

Dangerous and toxic organisms

Further Reading

Dietz, Robert S.
"The Sea's Deep Scattering Layers." Scientific American. August 1962.

Halstead, Bruce W.
Dangerous Marine Animals. Cambridge, Md.; Cornell Maritime Press, 1959.

Harvey, E. Newton.
Bioluminescence. New York: Academic Press, Inc., 1952.

Kriss, A. E.
Marine Microbiology (Deep Sea). New York: Interscience Publishers, 1963.

Marteka, Vincent.
Bionics. Philadelphia: I. B. Lippincott Company, 1965.

Ray, D. L., ed.
Marine Boring and Fouling Organisms. Seattle, Washington: University of Washington Press, 1960.

Film

Sounds in the Sea, 16 mm, black and white or color, sound, 16 minutes. Obtainable from Moody Institute of Science, Educational Film Division, 12000 East Washington Boulevard, Whittier, California 90606. Price: black and white, $60.00; color, $120.00.

Records

Sounds of the Sea and Sounds of Sea Animals, 33-1/3 L.P., recorded by W. M. Kellogg, produced by Florida State University Oceanographic Institute, Science Series, FPX 121 and FPX 125, Folkways Records and Service Corporation, 111 W. 46th Street, New York, New York.

9. FOOD FROM THE SEA

Concepts Covered

Fish protein concentrate

Fisheries management

Fish and shellfish farming

Comparison of U.S. with other countries in fish catch and consumption

Other forms of food besides fish

Most Thorough Coverage

Fish protein concentrate

Further Reading

Hull, Seabrook.
The Bountiful Sea. New York; Prentice-Hall, 1964.

Film

Manager of the Sea. 16 mm, black and white, sound, 15 minutes. Available on free loan from Institue of Marine Science, University of Miami, Rickenbacker Causeway, Virginia Key, Miami, Florida 33149.

10. AIR-SEA INTERACTION

Concepts Covered

Heat exchange at air-sea interface

Formation of winds

Evaporation and condensation

Exchange of chemical particles

Exchange of electrical energy

Hurricanes and typhoons

Methods of study of air-sea interaction

Most Thorough Coverage

Heat exchange at air-sea interface

Evaporation and condensation

Hurricanes and typhoons

Further Reading

Blumenstock, David I.
The Ocean of Air. New Brunswick, New Jersey: Rutgers University Press, 1959.

Dunn, Gordon E., and Banner I. Miller.
Atlantic Hurricanes. Baton Rouge, Louisiana: Louisiana State University Press, 1960.

Film

Air-Sea Interaction. Film strip, 35 mm, color, narrated on a record, 15 minutes. Address inquiries to Mr. Richard C. Vetter, Committee on Oceanography, National Academy of Science, National Research Council, 2101 Constitution Avenue, N. W., Washington, D. C. 20418.

11. SEA ICE

Concepts Covered

Ice formation

Stages of ice formation

Ice drift

Ice deformation

Ice decay

Ice prediction

Chemical changes in ice

Areal coverage of ice fields

Methods of charting ice

Icebergs

Most Thorough Coverage

Ice decay

Ice prediction

Further Reading

National Science Foundation
Antarctic Journal of the United States. Washington, D. C. 20550.

Wittmann, W. I.
"Polar Oceanography," in Ocean Sciences. E. John Long, ed., Annapolis: U.S. Naval Institute, 1964.

Film

Identification of Sea Ice. 16 mm, color, sound, 12 minutes. Available on free loan from Assistant for Public Affairs of local Naval District. When requesting, refer to: MN-7419-B.

12. ESTUARIES

Concepts Covered

Types and examples of estuaries

Fiords

Effect of rivers on estuarine environment

The relationship of organisms to estuarine environments

Sedimentation processes

Development of an estuary

Pollution

Submarine canyons

Surveys and research in estuaries

Most Thorough Coverage

Types and examples of estuaries

The relationship of organisms to estuarine environments

Further Reading

Reid, George K.
Ecology of Inland Waters and Estuaries. New York: Reinhold Publishing Corporation, 1961.

Film

Chesapeake Bay. 16 mm, black and white, silent, 17 minutes. Obtainable from Audio-Visual Center, Indiana University, Bloomington, Indiana 47405.

13. MAN AND THE SEA

Concepts Covered

Shipping and transportation

Man in the sea

Conservation

Pollution

Energy from the sea

Fresh water from the sea

Recreation

Ocean engineering

Dredging

Extracting natural resources from the sea and sea bottom

Offshore oil production

Legal aspects

Military aspects

Most Thorough Coverage

Conservation

Natural resources from the sea and sea bottom

Further Reading

Caidin, Martin
Hydrospace. New York: E.P. Dutton and Company, 1964.

Carlisle, Norman V.
Riches of the Sea. New York: Sterling Publishing Company, 1967.

Deacon, G. E. R.
Seas, Maps and Men. New York: Doubleday and Company, 1962.

Dugan, James, and Richard Vahan, eds.
Men Under Water. Philadelphia: Chilton Books, 1965.

Interagency Committee on Oceanography.
Undersea Vehicles for Oceanography. Washington, D.C.: U.S. Government Printing Office, 1965.

Saline Water Conversion Report--1966. Washington, D.C.: U.S. Government Printing Office, 1966.

Spiegler, K. S.
Salt Water Purification. New York: John Wiley and Sons, 1962.

Stewart, Harris B., Jr.
Deep Challenge. Princeton: D. Van Nostrand Company, Inc., 1966.

Films

Marine Resources. Film strip, 35 mm, color, narrated on a record, 15 minutes. Address inquiries to Mr. Richard C. Vetter, Committee on Oceanography, National Academy of Science, National Research Council, 2101 Constitution Avenue, N. W., Washington, D.C. 20418.

Man Invades the Sea. 16 mm, black and white, sound, 28 minutes. Obtainable from McGraw-Hill Text Films, 330 West 42nd Street, New York, New York 10036. Price: $165.00.

Ocean Engineering. Film strip, 35 mm, color, narrated on a record, 15 minutes. Address inquiries to Mr. Richard C. Vetter, Committee on Oceanography, National Academy of Sciences, National Research Council, 2101 Constitution Avenue, N. W., Washington, D. C. 20418.

14. INDIVIDUAL PROJECTS

Each student will present the highlights of an individual report or project that has been underway since the beginning of the course. If optional sessions are included, these presentations may be scheduled at the end of the course.

15. THE CONTINENTAL SHELF

Concepts Covered

World distribution of continental shelves

Relief and slope of shelves

Sediments of continental shelves

Life on the continental shelf

Turbidity currents and submarine canyons

Seasonal changes

The continental slope

Island shelves and slopes

Most Thorough Coverage

Relief and slope of shelves

Life on the continental shelf

Further Reading

Cromie, William J.
Exploring the Secrets of the Sea. Englewood Cliffs, New Jersey: Prentice-Hall, 1962.

Film

Geological Oceanography. Film strip, 35 mm, color, narrated on record, 15 minutes. Address inquiries to Mr. Richard C. Vetter, Committee on Oceanography, National Academy of Sciences, National Research Council, 2101 Constitution Avenue, N. W., Washington, D. C. 20418.

16. LIMNOLOGY

Concepts Covered

Origin and development of lakes, ponds, and streams

Physical and chemical properties and processes

Geological aspects

Organisms and their relationship to the environment

Recreation

Pollution

Conservation

Most Thorough Coverage

Organisms and their relationship to the environment

Further Reading

Frey, David G.
Limnology in North America. Madison: University of Wisconsin Press, 1963.

Gordon, Bernard L.
Adviser's Handbook. Highlands, New Jersey: American Littoral Society, Inc., Sandy Hook Marine Laboratory, 1964.

Film

Secrets of the Underwater World. 16 mm, color, sound, 16 minutes. Obtainable from Walt Disney Films, 477 Madison Avenue, New York, New York 10022. Price: $160.00.

17. UNDERWATER SOUND

Concepts Covered

Principles of underwater sound: transmission, reflection, refraction

Environmental factors that affect speed and path of sound in sea water

Uses of underwater sound

Underwater noises

Sound-reflecting organisms

Instruments for producing and recording sounds

Most Thorough Coverage

Environmental factors that affect speed and path of sound in sea water

Further Reading

U. S. Naval Oceanographic Office
Oceanography and Underwater Sound for Naval Applications. Special Publication No. 84, October 1965.

Swanson, Bernard K. (U.S. Naval Oceanographic Office) Oceanography for Long Range Sonar Systems. Part I. Introduction to Oceanography and Pysics of Underwater Sound in the Sea. Special Publication No. 79, February, 1966.

Film

Introduction to Underwater Sound. 16 mm, black and white, sound, 20 minutes. Available on free loan from Assistant for Public Affairs, local Naval District. When requesting, refer to: MN-8857.

18. CONSERVATION

Concepts Covered

Problem areas:

Overfishing

Pollution

Radioactivity

Protection of harbors and beaches

Possible solutions:

International agreements

Fishery management

Fish and shellfish farming

Control of pollution and radioactive waste disposal

Most Thorough Coverage

Pollution

Further Reading

Pell, Claiborne.
Challenge of the Seven Seas. New York: William Morrow and Company, 1966.

Film

The Management of Fisheries. 16 mm, black and white, 14 minutes. Obtainable from University of Miami, Institute of Marine Science, Rickenbacker Causeway, Virginia Key, Miami, Florida 33149.

19. ORIGIN OF THE OCEANS AND ORIGIN OF LIFE

Concepts Covered

Various theories of formation of the ocean basins

Geologic history of sea water

Theories of how life started

Development of life in the sea

Adaptation to land

Return to the sea

Most Thorough Coverage

Development of life in the sea

Further Reading

Carrington, Richard.
A Biography of the Sea, New York, Basic Books, Inc. 1960.

Rubey, W. W.
A Geological History of Sea Water, Geological Society of America Bulletin, Vol. 62, 1951.

Film

History Layer by Layer, 16 mm, color, sound, 23 minutes. Address inquiries to Lamont Geological Observatory of Columbia University, Palisades, New York, 10964.

APPENDIX A

SOURCES OF MATERIALS

Earth Science Curriculum Project. This project is developing new earth science teaching materials for use in secondary schools. Combined text, lab investigations, and teacher's guide (Investigating the Earth, Houghton Mifflin Company, 1967), reference pamphlets (Reference Series, Prentice Hall) have been published, and laboratory equipment is available (Damon Educational, Inc., Hubbard Scientific Company, and Macalaster Scientific Corporation). These have been tested at selected schools over a three-year period. Further investigations and equipment, visual aids, pamphlets, and films are being prepared. A quarterly newsletter will be sent free on request to: Earth Science Curriculum Project, P. O. Box 1559, Boulder, Colorado 80302.

Oceanography Information Kit. Available free to members of the National Oceanographic Association, Suite 301, 1900 L Street, Washington, D. C. 20036. Individual memberships in the Association are $10.00; student memberships, $3.00.

Student's Ocean Science Study Kit. Sample charts, list of references, career information, and an 80-page book on science and the sea. Price: $1.60. (Address below.)

Teacher's Ocean Science Study Kit. Contains the same items as the students' kits and in addition several booklets on hydrography and catalogs of films, charts, and publications as well as material relating to the study of oceanography by the Navy. Price: $3.20. Make check or money order payable to Naval Oceanographic Distribution Office, 3801 Tabor Avenue, Philadelphia, Pennsylvania 19120. Mail orders for purchases west of the Mississippi should be forwarded to the Naval Oceanographic Distribution Office, Clearfield, Utah.

APPENDIX B

SOURCES OF CHARTS

Geographical Society of America
429 West 117th Street
New York, New York 10027
(bottom charts of the Atlantic and Pacific Oceans)

National Geographic Society
Washington, D. C. 20036
(atlas of the world and special oceanographic charts)

U. S. Army Engineering District, Lake Survey
630 Federal Building
Detroit, Michigan 48226

U. S. Coast and Geodetic Survey
Environmental Science Services Administration
Washington Science Center
Rockville, Maryland 20852
(coastal charts off the U. S. with soundings)

U. S. Geological Survey
Interior Department
Washington, D. C. 20242
(topographic maps and geological structure)

U. S. Naval Oceanographic Office
Washington, D. C. 20390
(bathymetric charts of world oceans)

APPENDIX C

SOURCES OF MOVIES

Audio Visual Center
Indiana University
Bloomington, Indiana 47405

Bell System
Local representative or
affiliated company

Encyclopedia Britannica Films, Inc.
1150 Wilmette Avenue
Wilmette, Illinois 60091

McGraw-Hill Text Films
330 West 42nd Street
New York, New York 10036

Naval District
Local Assistant for Public Affairs

Films on Oceanography,
Publication C-4, 1966
National Oceanographic Data Center
Washington, D. C. 20390

APPENDIX D

SOURCES OF BIBLIOGRAPHIES

American Meteorological Society.
Collected Bibliographies on Physical Oceanography. 1965.

Emery, K. O., and Evelyn Sinha.
Oceanographic Books of the World 1957-1966. Washington, D. C., Marine Technology Society, 1967.

Gordon, Bernard L.
Aquatic Sciences Paperback Reference List. Boston, Northeastern University, September 1967.

Hahn, Jan.
A Reader's Guide to Oceanography. Woods Hole, Massachusetts, Woods Hole Oceanographic Institution, 1964.

Interagency Committee on Oceanography.
Bibliography of Oceanographic Publications. Washington, D. C., Science and Technology, ICO Pamphlet No. 9, April 1963.

National Oceanographic Data Center
Oceanography Reading List, Paperback Editions in print 1964-1965. Washington, D. C., Progress Report P-38, May 1965.

Sinha, Evelyn, and Lynda Strauss.
A Selected Bibliography of Oceanography Books Published between 1959 and 1966. La Jolla, California, Oceanic Library and Information Center, 1967.

APPENDIX E

SOURCES OF FURTHER INFORMATION

Organizations

Bureau of Commercial Fisheries
Fish and Wildlife Service
Department of the Interior
Washington, D. C. 20240

Coast Guard Headquarters
Commandant (CPI)
1300 E. Street, N. W.
Washington, D. C. 20004

Environmental Science Services Administration
Institute for Oceanography
901 South Miami Avenue
Miami, Florida 33130

Mission Bay Research Foundation
7730 Herschel Avenue
La Jolla, California 92037

National Oceanographic Data Center
Washington, D. C. 20390

Oregon State University
Marine Science Center
Newport, Oregon 97365

Superintendent of Documents
Washington, D. C. 20402

Texas University
Institute of Marine Science
Port Aransas, Texas 78373

University of Rhode Island
Graduate School of Oceanography
Kingston, Rhode Island

Publications

National Geographic: Washington, D. C. See Jun. 1967, Nov. 1966, Sept. 1966, Mar. 1966, May 1963, Mar. 1963, Jan. 1962, Apr. 1960, Oct. 1959, Mar. 1959, May 1957, Feb. 1957, Feb. 1956, Jun. 1955, and other issues.

National Geographic School Bulletin. Washington, D. C. See Apr. 1, 1963, Oct. 19, 1964, Nov. 2, 1964, Jan. 25, 1965, Feb. 22, 1965, Apr. 5, 1965, Oct. 18, 1965, Oct. 25, 1965, Apr. 25, 1966, and other issues.

"Oceanography," Part Six of American Practical Navigator. Bowditch, Washington, D. C., U. S. Naval Oceanographic Office, 1962.

Tsunami!; The Story of the Seismic Sea-Wave System. U. S. Government Printing Office, Washington, D. C. 20402.

APPENDIX F

SCIENTIFIC AMERICAN OFFPRINTS--A SELECTED LIST*

Rhodes W. Fairbridge, "The Changing Level of the Sea," May 1960 (Lectures 3, 15, 19).

Bruce C. Heezen, "The Origin of Submarine Canyons," August 1956 (Lectures 3, 15, 19).

Henry C. Stetson, "The Continental Shelf," March 1955 (Lectures 15, 3, 13).

Henry Stommel, "The Anatomy of the Atlantic," January 1955 (Lecture 1).

Walter Munk, "The Circulation of the Oceans," September 1955 (Lecture 5).

Robert L. Fisher and Roger Revelle, "The Trenches of the Pacific," November 1955 (Lecture 3).

Willard Bascom, "Ocean Waves," August 1959 (Lecture 5).

Joseph Bernstein, "Tsunamis," August 1954 (Lecture 5).

Herbert S. Bailey, Jr., "The Voyage of the Challenger," May 1953 (Lectures 1, 13).

James E. McDonald, "The Coriolis Effect," May 1952 (Lecture 5).

Willard Bascom, "Beaches," August 1960 (Lecture 1).

V. G. Kort, "The Antarctic Ocean," September 1962 (Lecture 1).

Robert Cushman Murphy, "The Oceanic Life of the Antarctic," September 1962 (Lecture 7).

Robert S. Dietz, "The Sea's Deep Scattering Layers," August 1962 (Lecture 8)

J. Tuzo Wilson, "Continental Drift," April 1963 (Lectures 3,19).

*These and other Scientific American "Offprints" may be obtained for $0.20 each from W. H. Freeman and Company, 660 Market Street, San Francisco, California 94104.

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